LASER WELDING IN MECHANICAL ENGINEERING

(COMPARISON OF SOME TYPES OF LASERS AND THEIR DEMAND)

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ЛАЗЕРНАЯ СВАРКА В МАШИНОСТРОЕНИИ

(СРАНЕНИЕ НЕКОТОРЫХ ВИДОВ ЛАЗЕРОВ И ИХВОСТРЕБОВАННОСТЬ)

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Аннотация. *В статье рассматривается лазерная сварка и ее виды в машиностроении. Авторы исследуют преимущества и недостатки лазерной сварки. Также в статье сравниваются некоторые характеристики видов лазеров и лазерная сварка в целом.*

Introduction. Welding is the main way to join metals permanently. Among diverse welding types, laser welding takes a special place. The types of laser welding can be classified according to energy characteristics, power density and duration of exposure. Laser welding can be divided into:

- microwelding;
- deep penetration welding;
- repetitively pulsed welding.

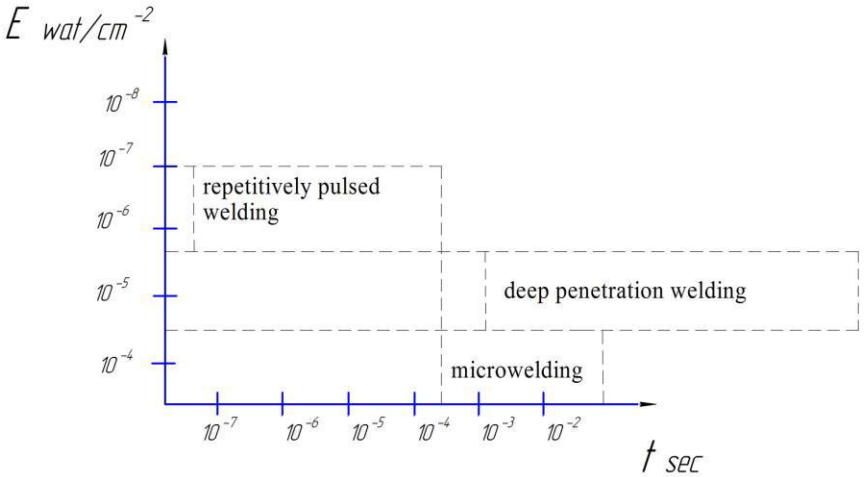

Fig. 1. Types of laser welding.

Research and results. Microwelding is mainly performed using a pulsed technique. A small diameter of the heat-affected zone ensures the locality and lack of deformation of the piece. During the pulse, the metal is heated to the melting point due to the thermal conductivity. Later it crystallizes. Microwelding ensures a high-quality joint of the pieces up to 1 mm in thickness.

Deep penetration welding allows welding of the material up to 20 mm in thickness in one pass. Continuous radiation from a powerful laser is used as a source of heating. The process occurs at the temperature of intensive evaporation of the metal with the formation of a penetration channel. The radiation penetrates deep into the material. When a channel is moved, a weld joint is formed. Radiation power is the main energy parameter of continuous welding (with the increase of radiation power, the depth of penetration also increases).

In heat-impulse welding, the energy of the impulse is determined by pumping voltage. Welding speed is the main parameter of this method. With the increase of the welding speed, the depth of penetration reduces. A repetitively pulsed laser can be used for cutting metals.

Laser welding has a number of advantages:

- minimal thermal influence and minimal deformation;
- high quality, evenness and repeatability of joint welds;
- strength of the metal of the joint welds;
- flexibility to manage the laser beam until it is delivered to the welding zone;
- possibility to weld hard-to-reach areas;
- high speed of application and high productivity of the process;
- automation and simplicity to control the process;
- multipurposeness (laser can be used for cutting, drilling and some other operations);
- hybrid technologies with the use of laser welding.

Despite the above mentioned advantages, laser welding has some disadvantages:

- quite expensive equipment;
- high requirements for the quality of the joint.

At present several types of lasers are used for welding in industrial production. Each laser has its own specific properties which determine the welding process. The most common in welding production are carbon dioxide (CO2), solid (with lamp or diode pumping) and fiber lasers. The most common types of lasers are shown in Table 1.

Table 1.

Comparison of the most common types of lasers

	Laser type				
	Diode	Diode-pumped solid-state	Lamp-pumped solid-state	Fibre-optic	CO_2
Wavelength, μm	0.98	1.06	1.06	1.07	1.06

Power range	10 W-10kW	From hundreds of watts to several kilowatts	From hundreds of watts to several kilowatts	From hundreds of watts to several kilowatts	From hundreds of watts to several kilowatts
Deep penetration welding	Yes	No	No	Yes	Yes
Coefficient of efficiency, %	40	15	5	25	10
Frequency of maintenance	2 years	1 year	3 month	2 years	6 month
Initial cost	Low	High	Average	High	Average
The cost of operation per hour / in dollars	23	53	51	43	49

Thus, the data in Table 1 allow saying that fiber optic laser has the best qualities. Generally, fiber lasers are compact and can use the air cooling of an active element.

Currently, diode-pumped solid-state laser and CO_2 laser are the most common in mechanical engineering. Diode-pumped solid-state lasers (DPSS) have a higher reliability, longer intervals in service cycles, lower cost of the consumed materials and details, but their initial cost is a considerable disadvantage. CO_2 lasers emit at a wavelength of 10.6 μm in the infrared range. Usually such lasers generate a radiation beam with a diameter from a few millimeters to a few centimeters. However, low efficiency and significant dimensions are among the main disadvantages of CO_2 lasers.

Conclusion. Laser welding is increasingly used in various industries, competing with traditional methods of welding. Laser welding should be used when it is necessary to create a structure with a practically unchanged shape and dimensions. It should also be used to join difficult-to-weld materials, including refractory and dissimilar materials. Multipurposeness and flexibility of laser equipment can be used in different processes, for example cutting, hole drilling, etc. Nowadays, solid-state and gas lasers are the most popular types of lasers. Fiber lasers have great prospects for the further widespread use. High cost of equipment and high energy costs are among the main challenges in the use of laser welding.

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